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ESRI • Summer 2004 GIS for Water Resources

In This Issue

The National Watershed Boundary Dataset

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The National Watershed Boundary Dataset (WBD) (see Figure 1) is a nationally consistent, topographically based set of hierarchical hydrologic unit boundaries coincident to and computationally integrated with both the National Hydrography Dataset (NHD) and the National Elevation Dataset (NED). The nested hydrologic unit delineations are based on the hypsography provided in the content of the U.S. Geological Survey 1:24,000-scale quadrangle maps and used through Digital Raster Graphics (DRG) integrated with hydrologically conditioned elevation data, high-resolution hydrography, and local knowledge. The WBD represents physical and hydrologic conditions throughout the United States and allows for aggregation of watershed information at different geographic scales. Specifically, the WBD contains a set of consistently derived, hierarchical, hydrologic unit delineations that possess unique identifiers at each nested level.

Responding to the national need for higher-resolution, hydrologic unit delineations referenced to larger-scale hypsography and hydrography, the WBD subdivides the current fourth level (8-digit, subbasins) at 1:250,000 scale into nested fifth level (10-digit, watersheds) and sixth level (12-digit, subwatersheds) at 1:24,000 scale. The WBD will supersede the original 1:250,000-scale hydrologic units at two, four, six, and eight digits and include the new 10- and 12-digit delineations. All levels of the WBD establish a baseline drainage boundary framework, accounting for all land surface areas. Standardization of the attribution structure of the hydrologic units allows for the aggregation of drainage information at different geographic scales and facilitates sharing and analysis of land management and natural resource data. The selection and delineation of the hydrologic unit boundaries is determined by applying science-based hydrologic and topographic principles, not favoring any political boundaries, special projects, or particular program or agency. The WBD provides a national framework for assigning hydrologic unit codes and names that will be useful to water management entities such as state water agencies, water conservation districts, and drinking water suppliers.

The WBD is a key component in establishing and implementing standards for quality, content, transfer of water data, and the coordination of the requirements for the collection of spatial data. Hydrologic Unit (HU) codes establish the locations of drainage areas within the entire unit hierarchy in a manner similar to street addresses. Once linked to the WBD by their HU codes, relations of water-related entities to any associated information can be analyzed using software tools ranging from spreadsheets to geographic information system (GIS) technology to engineering software. GIS technologies can also be used to combine WBD-based management unit analysis with other data layers, such as soils, elevation, land use, and population, providing a common reporting unit that can be linked to local or regional data sets. Because the WBD provides a nationally consistent framework and is linked with the NHD and the Elevation Derivatives for National Applications (EDNA), water-related information linked to HU codes by any one organization (national, state, or local) can be shared and easily integrated into many different types of applications, management, planning, and developmental activities. The WBD also can be used to preprocess a digital elevation model (DEM) to ensure that drainage basin boundaries derived from the DEM agree with

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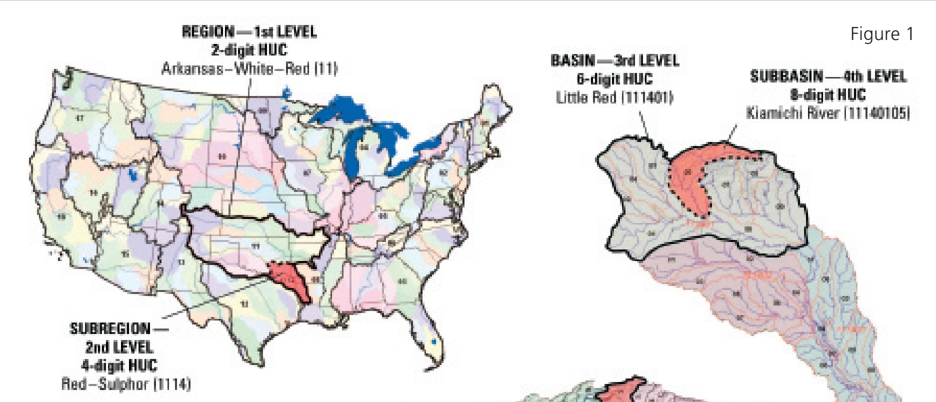
Figure 1



Hydrologic Unit

Level	Name	Digits	Average Size, in mi²	Units
1	Region	2	177,560	21
2	Sub-region	4	16,800	222
3	Basin	6	10,596	352
4	Sub-basin	8	703	2,149
5	Watershed	10	63–391 (40,000–250,000 acres)	22,000 (estimate)
6	Subwatershed	12	16–63 (10,000–40,000 acres)	160,000 (estimate)

San Antonio River

By William Burmeister
San Antonio River Authority

Because impervious ground cover has led to large-scale floods in the San Antonio River Basin, government organizations have sought solutions to reduce the impact of the events on the affected communities. Making the solutions more challenging is the geographical size of the basin. Numerous cities, towns, and rural communities lay within the four-county area. But in an unprecedented cooperative effort spearheaded by the San Antonio River Authority (SARA), government entities in the basin recently joined together to attack the problem with state-of-the-art modeling technology.

The San Antonio River Basin is located between 96.51, 99.35 degrees longitude and 28.27, 29.57 degrees latitude in south central Texas. It encompasses approximately 11,380 square kilometers (Figure 1). The basin is bordered on the west by the Nueces River Basin and on the east by the Guadalupe River Basin. The majority of the basin—the southern half—is primarily rural. The most heavily urbanized portion of the basin includes the city of San Antonio and its surrounding areas. San Antonio is located at the center of Bexar County and is densely populated with approximately 1.1 million people (as of 2000). The population of the entire basin is approximately 1.8 million.

In recent years, the city of San Antonio and the communities in the San Antonio River Basin have experienced significant loss of life and property due to flooding events. As a result, SARA, the city of San Antonio, and Bexar County signed an Interlocal Agreement (ILA) and began a joint, five-year effort to combine resources and build a Regional Watershed Modeling System (RWMS) using GIS technology and Arc Hydro Tools. The basic concept of the RWMS is the integration of the modeling components to establish an efficient and effective process for managing, planning, modeling, querying, analyzing, and maintaining the watershed's hydrologic, hydraulic, and water quality information in the San Antonio River Basin.

The RWMS project was designed to meet these specific goals.

- Inventory and review existing models (hydrologic, hydraulic, and water quality) and geospatial data for inclusion in the RWMS.
- Identify data poor areas of the San Antonio River Basin.
- Build tools for linking existing and proposed models using GIS and Arc Hydro.
- Develop standards for hardware, software, modeling, and geospatial data.
- Develop an RWMS that will facilitate flood mitigation planning, capital project prioritization, floodplain management, and development of a flood alert system.
- Develop a coordinated, cooperative regionwide working environment.

The five-year project began in 2003 with a data inventory. The ILA partners gathered information on all existing water quantity and quality models as well as all the geospatial data available from federal, state, ILA, regional, and local organizations. All the data was then ranked according to several parameters to determine its suitability for inclusion in the RWMS. The model and data inventory included some of the following: hydrologic, hydraulic, and water quality models throughout the region; land use/cover data; river delineations; watershed delineations; floodplain delineations; hydrology; hydraulic structures; flood and water quality data; topographic data; and basemap themes.

Cooperation among the ILA partners has already met with success because they were able to pool resources to obtain better aerial photography and more accurate topographic information from within Bexar County. This more regional approach led to each agency getting more for the resources they allocated for tasks such as planning the collection of data for areas of the San Antonio River Basin that are data poor.

Perhaps the most exciting aspect of the RWMS project has been the development of one of its subsystems—the Hydrologic Information System (HIS). This component of the RWMS consists of all the integrated hydrologic and hydraulic (H&H) modeling, the enterprise GIS, and an ArcIMS Web site for the delivery of the information.

The Center for Research in Water Resources at the University of Texas, Austin, and Texas A&M University were tasked with the development of a pilot HIS to test the feasibility of using Arc Hydro as a platform for combining H&H models. The Salado Creek and Rosillo Creek watersheds were chosen for the pilot HIS because of the availability of high-quality H&H models and GIS data. The result of this pilot study was the "Map2Map" concept.

This concept leverages the geoprocessing power of ArcGIS using a graphical modeling

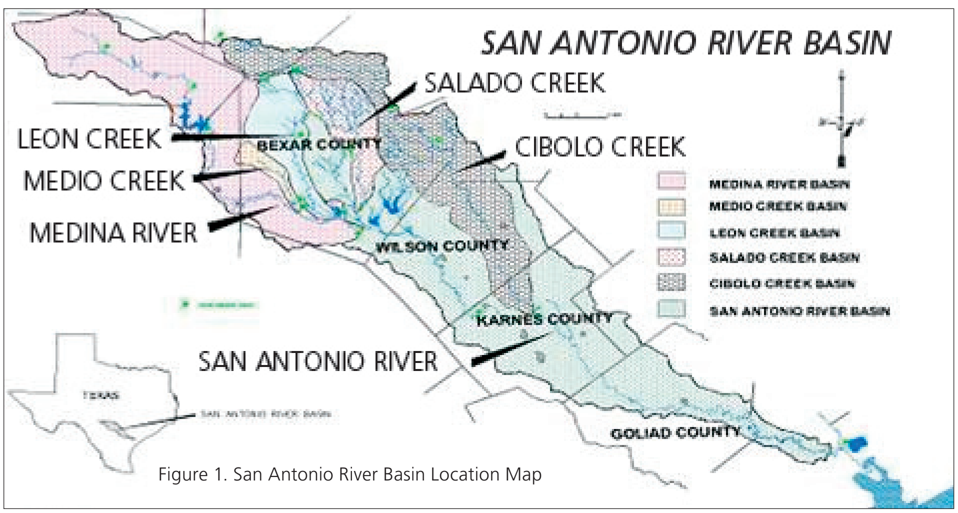


Figure 1. San Antonio River Basin Location Map

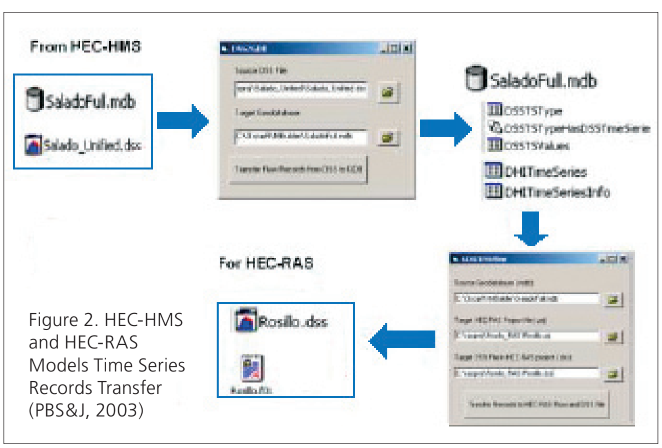


Figure 2. HEC-HMS and HEC-RAS Models Time Series Records Transfer (PBS&J, 2003)

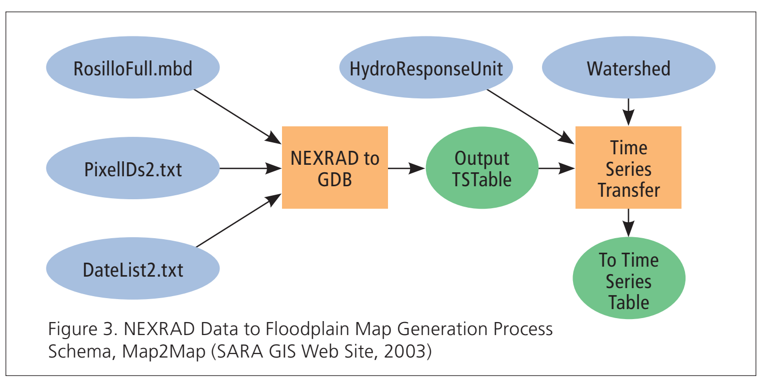


Figure 3. NEXRAD Data to Floodplain Map Generation Process Schema, Map2Map (SARA GIS Web Site, 2003)

environment, ModelBuilder, and the time series capabilities of Arc Hydro and model geodatabases (Figure 2) to automate the production of flood inundation maps starting with rainfall input. The pilot study begins with spatially referenced HEC-HMS and HEC-RAS (H&H models) and NEXRAD rainfall data from the National Weather Service. Within ModelBuilder, a Python script converts the NEXRAD data into a time series format that is compatible with the first model, HEC-HMS. It should be noted that the pilot study uses NEXRAD data, but any input hydrograph could be used as an input for HEC-HMS.

HEC-HMS then runs the hydrologic model and exports to a file that Arc Hydro converts to a format usable in the hydraulic model, HEC-RAS. HEC-RAS then runs the model of the hydraulic structures in the watershed (rivers, streams, channels, etc.) and produces another file that Arc Hydro converts into a format that can be combined with the grid of the area to produce a flood inundation map. The first portion of the ModelBuilder schematic is illustrated in Figure 3.

The ModelBuilder application produces in minutes what once took hours or days to accomplish manually. In addition, the modular nature of ModelBuilder allows great flexibility in the numbers and types of inputs to the system. For example, SARA can run the Map2Map model using NEXRAD data, then easily run different design storms through the model to study different flooding scenarios in near real time. This translates to a flexible, extensible environment in which model components, inputs, outputs, methodology, and overall work flow are easily documented.

ModelBuilder also gives the model flexibility because it allows it to be easily updated to show land use changes, topographical changes, or capital projects that will be built in the floodway to mitigate flood damage.

This tool brings the ILA partners closer to the goal of modeling flood inundation in near real time to assist basin communities with their flood mitigation and emergency response. The complete HIS model will be available to the general public through an ArcIMS Web site. Consultants and the general public will have the ability to check their vulnerability to floods during a rainfall event. Ultimately, this tool will be used by consultants and government agencies within the San Antonio River Basin to standardize the H&H modeling methodology and eliminate redundancy within the cooperating agencies. The Map2Map concept will also allow the ILA partners to share resources and, therefore, do more with the same or fewer resources.

William Burmeister is a watershed engineer with the San Antonio River Authority.

Streamlining Watershed Assessments

Alice Rankeillor, P.E., Storm Water Engineer, City of Gainesville, FL
Alan Foley, P.E., GIS Manager, Jones Edmunds and Associates

Advances in methods for data acquisition, analysis, and delivery are continuing to effect dramatic changes in the field of water resources and highlight the importance of database design. This article provides an overview of the Jones Edmunds and Associates, Inc., development and application of tools and techniques streamlining evaluation of the Sweetwater Branch watershed in Gainesville, Florida. GIS and GPS tools were central to the success of the project. Methods and resources employed in this project continue to evolve with developments in GIS and GPS. Models produced during watershed evaluations were typically snapshots in time requiring extensive or even complete revision for future studies dependent on levels of change in the watershed. A GIS-centric approach brings flexibility and scalability to watershed assessment efforts, with resultant data providing an easily modified basis for future updates.

A GIS-centric approach was used on the Sweetwater Branch watershed, which covers almost three square miles with surface water drainage via the Sweetwater Branch and its tributary, the Rosewood Branch. The northern portion of the watershed is urban with extensive underground storm sewer systems conveying water to the stream system. The southern portion of the watershed is a mix of open land, light industry, and medium density residential development. The stream system ultimately discharges to Alachua Sink—a sinkhole connected to the Floridan Aquifer—on Payne's Prairie State Preserve.

Watershed evaluation began with data collection in stream channels. Data collected would support a hydraulic model and geomorphic analysis of the stream. Field crews collected representative stream reach data including cross-sectional elevation profiles, movable sediment profiles, bank soil composition, vegetation canopy, trash, and photographs. All stream reach data was recorded in a spatial format and made accessible via an ArcIMS Web site (http://209.208.11.222/swb). Hyperlinks from the mapped cross sections on the ArcIMS site launched individual pages for review of individual reach data.

Additional watershed data was collected to support a hydrologic model and nonpoint source (NPS) pollutant loading assessment. Merrick, Inc., collected LIDAR data suitable for generation of one-foot elevation contours. Merrick's MARSExplorer software was used to process the LIDAR data and develop a two-foot resolution GRID. ArcGIS Spatial Analyst and the Arc Hydro Tools toolbar were used to process the GRID for development of hydrologic and hydraulic models. The city of Gainesville provided a geodatabase of storm water infrastructure, which was used to further refine the GRID. Several storm sewer systems ran against the land surface grade and, thus, changed basin boundaries.

The U.S. Army Corps of Engineers Hydrologic Engineering Center (HEC) Geospatial Hydrologic Modeling System (GeoHMS)—an ArcView 3.x

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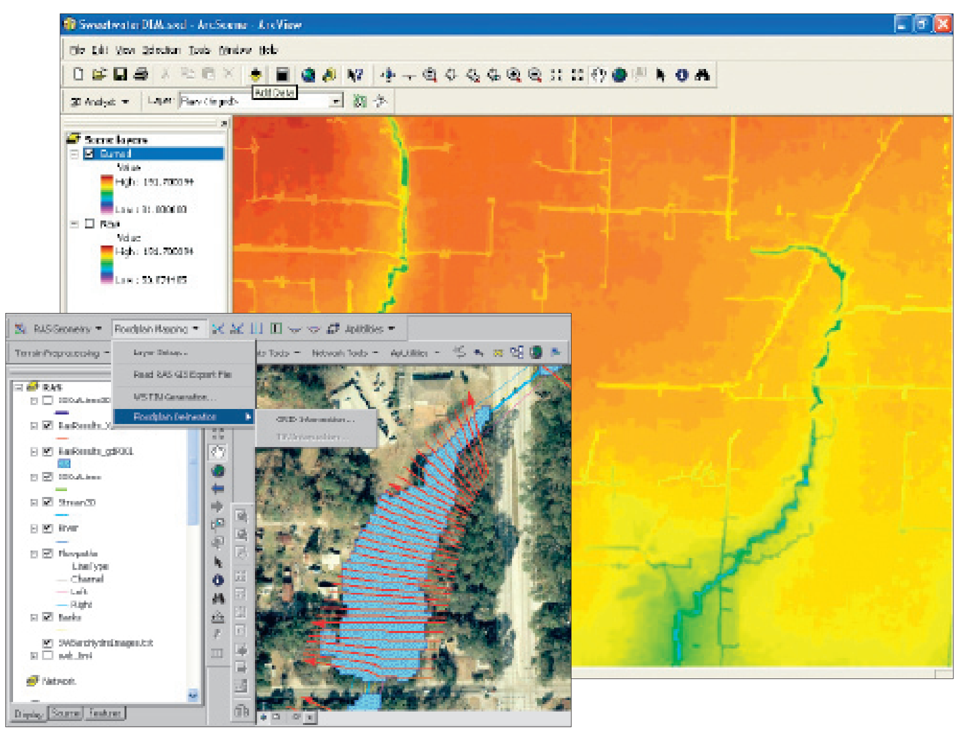
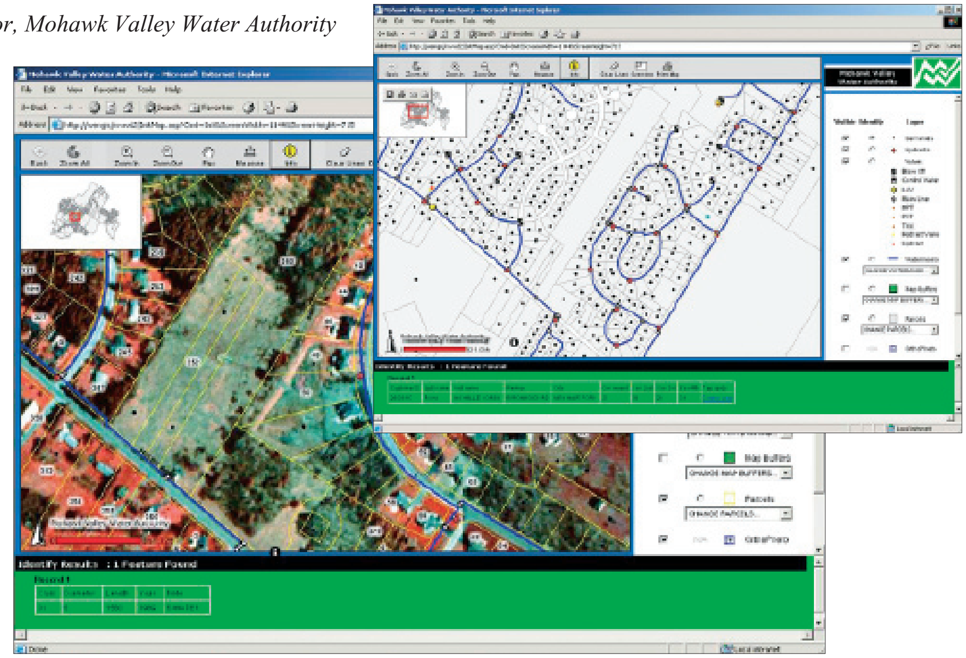


Geodatabase Outperforms Coverages and Shapefiles

When querying watershed event data

By Elisabetta Degironimo, Watershed Coordinator, Mohawk Valley Water Authority

This article describes the findings of a master's thesis examining spatiotemporal event management (using a GIS) as it relates to watershed hydrological data.



A spatiotemporal event is something that happens at a specific location at a specific point in time. In the context of watershed management, a spatiotemporal event could be a single stream flow reading or the collection of a water quality sample. Each happens at a specific location at a specific moment. The objective of the thesis study was to determine if there is a computational advantage to using a geodatabase over the coverage or shapefile data type when querying watershed hydrological event data.

Discipline specific data models have been developed for ArcGIS including one for water resources called Arc Hydro. The time series object class of the Arc Hydro data model has the capacity to store hydrological temporal event data. The advent of the Arc Hydro data model with a time series component is ushering in mainstream usage of hydrological event data within a GIS.

The ability to query by time and location is important to scientists and engineers studying hydrological data. It is of interest, for example, to be able to access all stream gauge, rainfall gauge, and water quality data collected during a particular storm event for a given watershed. There should be an advantage to using a geodatabase (Arc Hydro) to access this hydrological event data because of the object-oriented (less abstraction of geographic phenomena) structure of ArcGIS. The time series object class in Arc Hydro was designed to handle this type of data.

To determine if there is a computational advantage to using a geodatabase, a framework watershed GIS (Arc Hydro Framework with Time Series data model), which included subwatersheds, water bodies, streams, and monitoring points, was created for the West Canada Creek watershed in central New York State using each of the three data types (geodatabase, coverage, shapefile). The same source data was used to create each of the three data sets. Thirty queries were constructed and programmed in Visual Basic for Applications (VBA) to run independently of user intervention. The 30 queries were executed 10 times on each of the three data sets (900 total query runs). The time, measured by elapsed system time (according to the battery-operated computer clock), to complete each query was automatically recorded in a text file. The results were statistically analyzed.

The spatiotemporal event data for the study was downloaded from the National Water Inventory System (NWIS) Web site. The event data from NWIS (64,285 records) was loaded into a Microsoft Access database (TimeSeries table in Arc Hydro). It contained stream gauge as well as water quality information. Records in the TimeSeries table were related to the MonitoringPoint data set that contained points representing the 33 event locations in the watershed. The HydroID field in the MonitoringPoint file was related to the FeatureID field of the TimeSeries table (as it is in the Arc Hydro data model).

When querying event data in a GIS, four query outcomes are possible.

1. Features on the map are selected.
2. Records in a related table are selected.
3. Both features and records in a related table are selected.
4. Nothing is selected.

This study considered the first three outcomes listed above. The fourth outcome was not considered because it does not produce a visible result set (to assure that the query worked). To ensure that either features or records were selected, the event data was analyzed, and queries that selected varying numbers of records and/or features were composed. The queries were also designed to have varying degrees of complexity. The first type of query is considered a spatial query; the second, a tabular query; and the third, a mixed (or compound) query. Of the 30 queries executed against each of the three data types, 10 were spatial, 10 were tabular, and 10 were mixed.

By pressing a button in the button bar, the user launches the control program (written in VBA) that calls each of the queries. The queries each have a timer that starts after they are called and stops after

Example Queries

Query Type	Description	Tables Queried	Records Selected
Spatial	Select all spring or lake/reservoir monitoring points.	MonitoringPoint	6
Spatial	Select all stream monitoring points in the Center or Middle West Canada Creek subwatersheds.	MonitoringPoint	14
Tabular	Select all gauge readings for July 4–5, 1992.	TimeSeries	2
Tabular	Select all water quality samples taken 1990 or after with a total coliform count >= 1000 colonies/100 ml.	TimeSeries	6
Mixed	Select all monitoring points (event sites) with a pH reading <6 in the Middle West Canada Creek subwatershed in 1994.	MonitoringPoint TimeSeries	11
Mixed	Select all gauges with readings > 10,000 cfs in March.	MonitoringPoint TimeSeries	2 13

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HDR

HDR is an architectural, engineering, and consulting firm that excels at complex projects and solving challenges for clients. More than 3,300 employee–owners, including architects, engineers, consultants, scientists, planners, and construction managers in more than 90 locations worldwide, pool their strengths to provide solutions beyond the scope of traditional A/E/C firms. Headquartered in Omaha, Nebraska, HDR is ranked number 18 in the 2004 Engineering News–Record Top 500 Design Firms survey.

HDR has thriving business practices in water/wastewater and water resources. The company's comprehensive services range from designing and managing potable water and wastewater infrastructure to environmental permitting and wetlands and habitat preservation. GIS plays a vital role in many of these solutions, and HDR uses ESRI products to support diverse client needs from large watershed studies to floodplain studies and asset management programs.

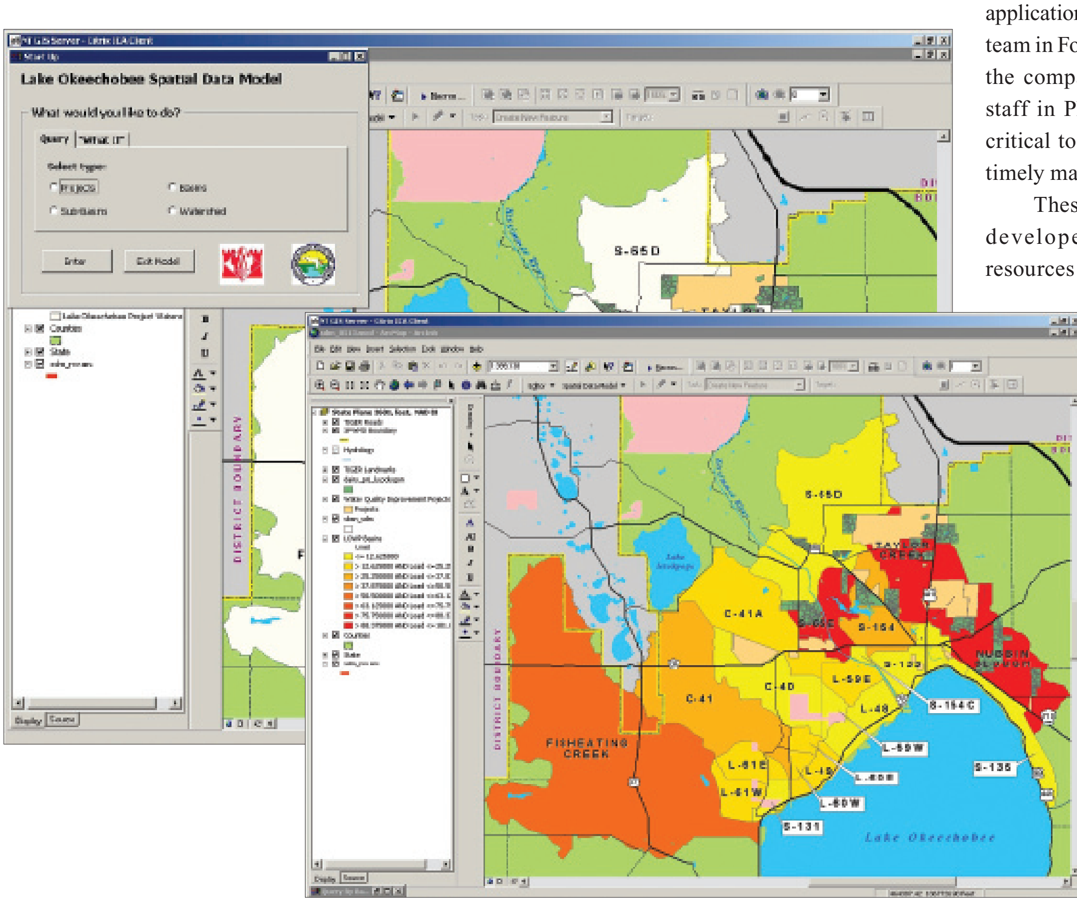
A prime example is HDR's work on the Lake Okeechobee Watershed Project, one of the first major components of the $7.8 billion Comprehensive Everglades Restoration Plan. As a consultant to the South Florida Water Management District, HDR leads the planning effort to identify the optimum type, location, and size of reservoirs needed to reduce the phosphorus pollution and freshwater discharges reaching Lake Okeechobee. HDR developed a land suitability model using ArcGIS Spatial Analyst to identify potential reservoir sites that met environmental and engineering criteria. Using ArcObjects, HDR developed a decision support system that allows SFWMD staff to conduct real-time, what-if analysis of alternative pond designs when meeting with the regulatory and resource agencies making up the LOWP project development team.

The work HDR performed for the city of San Diego illustrates how the company applies ArcGIS tools to an asset management program. The city operates and maintains a municipal wastewater collection system of about 2,900 miles of sewer pipe serving a population of more than 1.2 million people. In the late 1990s, the city noted increases in sanitary sewer overflows (SSOs) from the wastewater collection system—as many as 300 SSOs per year. With HDR's help, the city-implemented, innovative GIS-based programs reduced sewer overflows by 60 percent. To support an aggressive campaign to clean every pipe in the wastewater collection system within two years, HDR developed the PSTOOLS maintenance management system using ArcGIS and ArcObjects. The PSTOOLS system enables a maintenance

coordinator to quickly identify pipes that are due for cleaning using a customized ArcGIS interface. PSTOOLS grouped together maintenance work orders for pipe segments in a common geographic area to minimize the amount of time cleaning crews spent driving among sites.

The Federal Emergency Management Agency selected HDR for a five-year Indefinite Delivery/Indefinite Quantity (IDIQ) contract to conduct coastal and riverine flood studies throughout Region IX, an area consisting of California, Arizona, and Nevada. HDR's FEMA Region IX IDIQ team uses ArcGIS with Arc Hydro and other hydrologic and hydraulic modeling tools to delineate the limits of flood hazard areas and produce digital flood insurance rate maps suitable for publication in accordance with FEMA specifications. By using Citrix Metaframe XP application servers running ArcGIS, HDR's FEMA team in Folsom, California, can collaborate across the company's wide area network with on-site staff in Phoenix or Nevada, which could prove critical to providing disaster recovery maps in a timely manner.

These are a few of many GIS applications developed by HDR to support its water resources clients at the local, state, and federal government levels. From mobile GIS applications using ArcPad to enterprise solutions using ArcSDE and ArcIMS, HDR is an ESRI business partner that employs the full range of ESRI software products for the benefit of its clients.



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Streamlining Watershed Assessments

extension in the process of being upgraded to ArcGIS—was used to preprocess watershed GIS data and export it to the HEC Hydrologic Modeling System (HMS), where a kinematic wave overland flow model was developed and run. HEC's Geospatial River Analysis System (GeoRAS)—Beta 4.1 for ArcGIS—was used to preprocess channel GIS data and export it to HEC's River Analysis System (RAS), where an unsteady flow model was developed and run using the input hydrographs from the HMS model. GeoRAS was used to import the RAS model results into ArcGIS for floodplain mapping. The NPS pollutant load assessment was performed within ArcGIS using spatial data representing soils, land use, and storm water treatment facilities within the watershed.

The combination of available data, rapidly acquired field data, and the tools to process the data enabled a fine scale assessment of the Sweetwater Branch watershed. All office and field data compiled for the models in this project are linked and available via ArcGIS. Since the completion of this project, advances in hardware—such as cellular modems extending the range of real-time kinematic GPS—and software—such as disconnected geodatabase editing in ArcPad and XML translations of data from a geodatabase to a modeling package and back to the geodatabase—have allowed further refinement in techniques, resulting in virtually seamless transmission of data from the field to a model to design of drainage improvements.

The challenge for water resources engineers is beginning to switch from obtaining the necessary data to adequately filtering and organizing the abundance of data that may be available. Database and geodatabase design will become increasingly important for water resources projects. A well conceived, simple geodatabase design can make field data collection more efficient and minimize or even eliminate field data incorporation into hydrologic and hydraulic models. As tools and techniques enable collection, compilation, and integration of larger data sets, water resources engineers will benefit from an increased understanding of geodatabase design.

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Geodatabase Outperforms Coverages and Shapefiles

Data Type Comparison (for West Canada Creek Watershed) (Arc Hydro Framework With Time Series Schema)					
Shapefile		**Coverage**		**Geodatabase**	
Number of Files	File Size (sum of all files)	Number of Files	File Size (sum of all files)	Number of Files	File Size (sum of all files)
36	7.87 MB	71	7.56 MB	1	9.59 MB

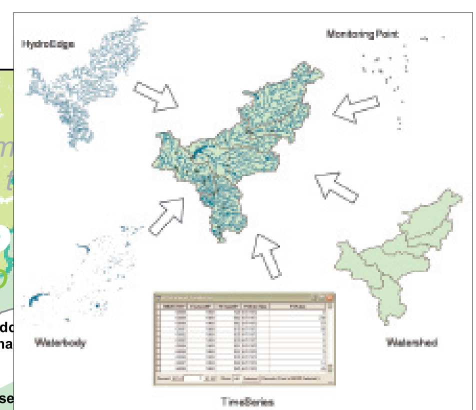
the individual query is executed. Once the timer stops, the elapsed time (system time recorded to a precision of 10-7 seconds), along with the query name and data type, is written to a text file before control is passed back to the control program. The control program terminates after each of the queries has been run 10 times.

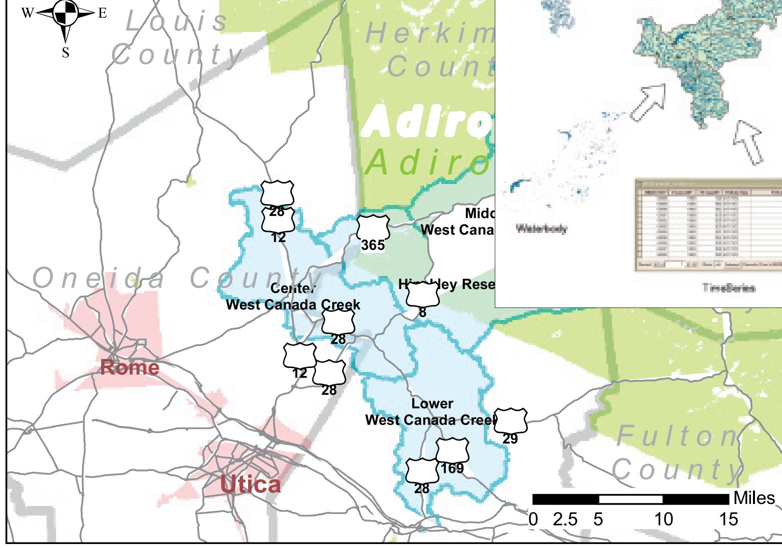
Once all the queries were run for each of the data types, the results were statistically analyzed (GLM ANOVA). Of the 30 queries, the geodatabase was the fastest to process 22. The coverage was fastest for the remaining eight and in many cases, the performance of the shapefile was only slightly slower than that of the coverage.

As a group, the spatial queries were quickest to process (none took longer than 0.3 seconds). The next fastest were the tabular queries (the slowest executed in less than one second). The slowest queries were the mixed queries. These were the most complex, since they used a relate to select both features and any related tabular records. Five of the mixed queries executed in less than one second (for all data types). Three of the queries executed in one to three seconds. The remaining two queries took approximately 64 and 274 seconds, respectively, to execute. Because one of the assumptions of an ANOVA (i.e., equal variance within each group) was not met, a logarithmic transformation of the response variable (i.e., query time) was necessary.

Results of this study indicate that, statistically, the geodatabase is significantly faster than the coverage or shapefile data types. This study showed that there is a computational performance advantage, in terms of elapsed system time, to using the geodatabase data type (Arc Hydro Framework with Time Series data model) over the coverage or shapefile data types when querying spatiotemporal hydrologic event data in ArcGIS. The geodatabase offers additional advantages over the coverage and shapefile such as storing all data in one computer file and being object oriented. Because it's object oriented, features stored in the geodatabase are objects that can have properties and methods. The ability to have methods (programming code stored within the object) allows the object to exhibit behavior.

The geodatabase and Arc Hydro data model show promise for managing spatiotemporal hydrological data. As it is currently designed, the Time Series component of the Arc Hydro data model is better suited to handle gauge data than water quality data. However, the user always has the option of modifying the Arc Hydro data model to better suit a given project. In fact, the purpose of developing data models, such as Arc Hydro, is to provide a starting point when developing a discipline specific geodatabase design.





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The National Watershed Boundary Dataset

the previously developed and verified boundaries of the WBD. More information regarding this procedure can be found at http://nhd.usgs.gov/applications.html#nhdwatershed.

A multiagency committee has been established to ensure communication and coordination efforts among state and federal agencies and private interests while creating the WBD. This multiagency coordination effort ensures that all organizations have access to a consistent and nationally accepted set of drainage delineations. This reduces redundancy while encouraging interagency collaboration and the most efficient use of resources. The actual delineation methods vary from state to state as do the agencies involved in the coordination and development process. The software used to delineate the drainage areas includes the suite of ESRI* products and tools. However, with the federal standards in place, along with interim reviews, support, and evaluation of methods by regional and national coordinators, the approaches adopted by individual states are transparent within the seamless structure. The national and regional WBD coordinators have stimulated interest, as well as financial and managerial support, by conducting delineation workshops throughout the nation. Each workshop was specifically designed to address the needs of every contributor. By doing so, local, state, and federal agencies in each state were able to consolidate resources and expedite the development of WBD compliant delineations.

Release of the Federal Standards for Delineation of Hydrologic Unit Boundaries was made available via the Natural Resource Conservation Service (NRCS) Geospatial Data Gateway in January 2003. As expected, individuals, businesses, and all levels of government have utilized this new data resource. WBD compliant drainage area delineations are already playing a role in the management, analysis, and protection of water resources and in related concerns. Examples of how WBD compliant delineations are being used for water resource activities include

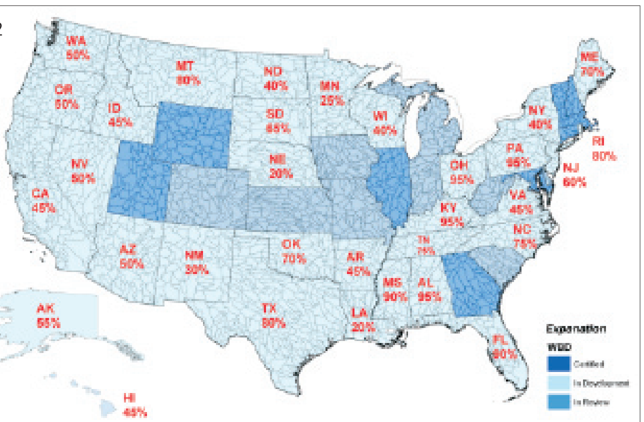
- Emergency watershed protection programs
- Floodplain management studies
- Dam failure emergency preparedness plans
- Prioritization of watersheds for the 319 grant program in Ohio
- Watershed planning for the upper Klamath River basin in Oregon
- A base layer in the Statewide Information Management and Monitoring System (SWIMMS) model in Kansas
- Storm water studies by regional, county, and private entities and the permitting of water and sewer treatment plants in South Carolina
- Prioritization of areas by WBD compliant hydrologic units as part of the California Clean Water Action Plan
- A report management tool for Total Maximum Daily Load (TMDL) estimates in Indiana, Ohio, Iowa, and North Carolina

WBD compliant hydrologic unit delineations have been used in many engineering studies, conservation, and natural resource activities including, but not limited to

- Burn area rehabilitation
- Environmental Quality Incentives Program (EQIP) and PL-566 programs in Iowa
- Tracking of the Conservation Reserve Program and Conservation Priority Areas
- Natural resources conservation programs on U.S. Army bases in North and South Carolina
- Aquatic and Riparian Monitoring Program as part of the Northwest Forest Plan of the U.S. Forest Service and Bureau of Land Management
- Engineering and planning for site development
- Oregon soil and water conservation districts that are required to report their annual progress by hydrologic units to the Oregon Department of Agriculture
- The calculation of flood flows at culverts and bridges, South Carolina Department of Transportation
- Floodplain management studies, environmental quality incentives programs, and more

Once completed, the seamless WBD will also be incorporated into the structure of the Arc Hydro* data model. The Arc Hydro data model and tools are the result of collaboration between GIS users in federal, state, and local governments; university researchers; and ESRI. The model will provide a streamlined structure in which the WBD can be integrated with other national data sets such as the NHD and NED.

Figure 2



To date, 11 states have been certified and meet the Federal Standards for Delineation of Hydrologic Unit Boundaries (see Figure 2). The other areas of the nation are in various degrees of completion, the majority of which are awaiting final attribution, edge matching with adjacent states, or funding to finalize the conversion of concept delineations.

The WBD will be housed at the USDA–NRCS National Cartography and Geospatial Center, where it is being distributed to the public through the Geospatial Data Gateway. Currently 11 states are available for distribution through the Geospatial Data Gateway. Another 20 states are in the final stages of delineation, edge matching, and attribution. These states should be released for distribution later in 2004. Along with the WBD state meetings, a panel discussion is scheduled for the ESRI* International User Conference in August 2004. Additional activities and progress can be viewed by visiting the official WBD Web site.

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